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MRS. T. R. BROWN, Secretary
Route 2, Box 81
Thermal, California

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Thirty-Ninth Annual **DATE GROWERS' INSTITUTE**

HELD IN
COACHELLA VALLEY

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VOLUME 39

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DATE PEST CONTROL STUDIES

H. S. Elmer

University of California Citrus Research Center and
Agricultural Experiment Station
Riverside, California

During the past year tests were made in the field to substantiate previous data obtained on the control of mites and insects that adversely affect date palms or date fruit (Elmer 1961). The control studies included testing the effectiveness of various pesticides as well as comparing methods of applying these pesticides. The primary pests involved in date culture control practices during 1961 were the same pests that have continued to be of most concern to date growers for the past 10 years, namely the Banks grass mite, *Oligonychus pratensis* Banks, and the nitidulid beetles which include the cornsaw beetle, *Carpophilus dimidiatus* (Fab.), the dried fruit beetle, *C. hemipterus* (L.), the pineapple beetle *Urophorus humeralis* (Fab.), and the yellowish nitidulid, *Haptoncus luteolus* (Er.).

The Banks grass mite has been the most recurrent pest of dates over the past years probably because large significant population increases normally occur under the conditions of high temperature and low humidity found in the date growing regions of southern California. (The opposite is true of the nitidulid beetles as they occur in the greatest number only in years when the humidity is abnormally high.) The grass mites are incapable of flight and do not spin silk strands and float on the wind as some mites do so their main means of dispersal besides walking probably is by transportation on particles of dust and debris during periods of strong winds which are quite common to the area. The rather rapid reinfestation of experimental plot areas consisting of only a few trees was believed to be primarily due to these high winds.

Mite control experiments were designed to give the following types of information: 1) evaluation of the effectiveness of certain acaracides when applied as sprays in comparison with sulfur applied as both a spray and a dust, 2) evaluation of the effectiveness of oil in combination with sulfur and sulfur alone, applied as sprays during the winter and spring when mite populations were low, in retarding the appearance of mites in early summer, and 3) wettable sulfur dosage studies on tall date palms.

All plots were additionally used to observe the effectiveness of spray

equipment as well as to check phytotoxic injury to the trees and fruit.

1. A series of replicated plots was sprayed in May, 1961, with a number of acaracides for comparison with sulfur treated plots (the sulfur was applied both as a spray and as a dust). Kelthane, Tedion, Eradex, and chlorobenzilate were tested at a dosage of one-fourth pound actual toxicant per 100 gallons of water and the wettable sulfur plots were sprayed with 4 pounds per 100 gallons of water. These dosages were applied at the rate of approximately 100 gallons per 15 trees. In the dust plots sulfur was applied at the rate of one pound per tree. Untreated check plots were included in the tests and in all cases developed extremely high infestations of Banks grass mite by mid-June. All of the sprayed and dusted plots remained free of mites until the end of June but mites were observed in many of the plots in July and the entire date garden was dusted. No mite injury was found on any of the dates in the treated plots at harvest time but considerable scarring occurred on the fruit from the untreated check plots.

2. Vincent and Lindgren (1958) reported that the Banks grass mite persisted in date gardens during the winter on the white tissue of the date leaf bases and on grass. With this in mind it was hoped that the elimination of mites from date gardens at a time when populations were low might prevent infestations on the fruit or at least retard the reappearance of the mites.

Wettable sulfur or wettable sulfur and oil combinations were sprayed on various plots in January, February, and March. Wettable sulfur was used at the rate of 4 pounds per 100 gallons of water alone or in combination with 2 quarts of light medium oil emulsion. The whole tree was sprayed as well as the grass sur-

rounding the date palm. There was no phytotoxicity to the trees and the fruit yield was comparable in both size and quality at harvest time to the fruit on adjacent trees not treated during the dormant period. However, there were no significant differences observed between sprayed trees and untreated check trees regarding the numbers or the time of appearance of mites on the fruit in May.

3. Wettable sulfur sprays were applied to a series of replicated date palm plots in August at different dosage levels. These treatments were applied with a conventional high pressure citrus sprayer using a shade tree gun which is capable of delivering the spray to date bunches furthest from the ground. The results are shown in Table 1.

All of the dosages gave adequate control of this mite but the 4 pound dosage had a few bunches in each of the three replicated plots reinfested after 35 days while the 6, 8, and 10 pound dosages were free of mites for the duration of the experiment. A thorough drenching with water failed to reduce the mite populations. Date spoilage or cracking did not occur in any of the sprayed plots.

Nitidulid Beetle Control

Sevin, Diazinon and Malathion dusts and sprays were applied for the control of nitidulid beetles during the fall when the dates turned color. Very low populations of beetles developed in the area selected for these tests and adequate evaluations of the effectiveness of the various test materials could not be obtained. However, there was considerable infestation of the fruit in these plots by two different species of moths, the rasin moth, *Eplestia figulilella* Greg. and the Indian-meal moth, *Plodia interpunctella* (Hbn.). Tests are planned for 1962 using these materials and others for the control of both the nitidulid beetles and the two species of moths.

Table 1.—Effectiveness of various dosages of wettable sulfur applied August 1, 1961, as sprays for the control of Banks grass mite.

Plot	Lbs./100 Gals.	Days Effective
W. Sulfur	4	35
W. Sulfur	6	60+
W. Sulfur	8	60+
W. Sulfur	10	60+
Water	----	0
Untreated	----	0

Summary

Sulfur used as a dust or as a spray is as effective in reducing populations of Banks grass mite on dates as any of the acaricides tested in 1961 and 1962. These sulfur applications need to be properly applied to assure maximum effectiveness. As a dust the sulfur should be blown up through the bunches of dates while wettable sulfur sprays at dosages ranging from 6 to 10 pounds per 100 gallons gave control for a longer period of time than did a 4 pound

dosage. Sprays applied when the evaporation rate was high did not cause injury to the green or ripe fruit and there was no indication of any reduction in fruit yield or quality. Phytotoxicity was not observed on date palms that were sprayed with sulfur and sulfur in combination with oil during the winter when the evaporation rate was low.

Nitidulid beetle populations were relatively low during 1961 and adequate evaluation of the effectiveness of the various test materials could

not be obtained. The application of sprays to ripe fruit did not increase spoilage in the date bunches.

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A STUDY OF FRUIT DEVELOPMENT AND METHODS AND DEGREES OF FRUIT THINNING IN SOME EGYPTIAN DATE VARIETIES¹

A. Naguib El-Fawal²

Specialist, Division of Fruit Research, Department of Horticulture,
Ministry of Agriculture, Cairo, Egypt

Date culture in Egypt extends from north to south, from the relatively cool and humid region of the Mediterranean to the extremely hot and dry region of Aswan. The varieties grown include soft, semi-dry and dry dates, according to the prevalent environmental conditions.

The date, acreage, production and value, is far in the lead of all kinds of fruits in Egypt. There are approximately 6 million bearing palms and 1.1 million non-bearing palms in Egypt (16), which would occupy about 85,000 acres, on the basis of 49 square meters per tree. This does not include the palms grown in the deserts and Western Oasis (16).

PART I FRUIT DEVELOPMENT

As far as the term *fruit growth* is concerned, many workers consider that it begins with pollination. It is the viewpoint of others that it begins when the initiation of the tissues which constitute this fruit takes place. In this respect, it might be more convenient to use the term *development* rather than *growth*, as the first term might cover all the life history of the fruit including (a) flower initiation, (b) the pre-bloom stage, (c) the blooming stage, (d) the post-bloom stage, (e) the horticultural ripening of the fruit, and (f) the postharvest changes.

MATERIALS AND METHODS

The present study included the effect of defoliation in July and October, 1955, on the development of flower buds, and the growth of the spadices prior to blooming in the Zaghloul variety. The study included

some observations on the nature of flowering in dates.

Experiments were conducted to study metaxenia (the direct effect of pollen) in four soft date varieties; Samany, Zahgloul, Hayany and Bent Aisha grown in two different types of soil; unirrigated sandy and cultivated loamy soils, in the coastal section of Egypt, during 1953-1958. Pollens were selected from different districts from Middle Egypt, Lower Egypt and the coastal section. Different pollens were applied on different strands on the same bunch, using the same technique introduced by Nixon (9).

The post-bloom development of the four soft varieties mentioned above grown under the same conditions was studied during the 1953, 1954 and 1956 seasons. Only one season's data (1956) of one variety (Samany) grown in the loamy soil will be presented. Six bunches on 6 different palms were chosen for measurements. No attempt was made to measure the rate of growth until the June drop had ceased, and all the unfertilized carpels had dropped. This was approximately during the second half of June when the bunches were pulled down. Weekly samples were picked at random from strands located in different parts of each bunch. Measurements began on June 28 (10 weeks after pollination) up to November 8, 1956.

RESULTS AND DISCUSSION

Flower-bud, differentiation and growth

Early studies of Faries (5), Albert and Hilgeman (1), Hilgeman (7) and the present work indicate

that the flowering buds of any particular year are continuous and grow out from the axils of the uppermost (younger) of those leaves which expanded and functioned the year before. The lower (older) leaves of the same year have undeveloped buds in their axils.

The number of buds that differentiate into inflorescences out of the total number of buds in a given year depends upon the functional leaf surface, and the amount of crop in the preceding year. It was found that successive removal of all mature functioning leaves in July and October, 1955, caused the death of their buds, even those which would produce the

¹The results presented formed part of the Master's thesis of the writer, presented to the Graduate Division, University of Alexandria, Egypt, in June, 1958.

²The writer expresses his appreciation to Dr. H. A. Baghdady, formerly Head Department of Pomology, U. of Alexandria, under whose supervision this study was carried out. He is also grateful to Dr. F. A. Minessy Associate Professor of Pomology, U. of Alexandria, for his invaluable assistance during the course of the study and the preparation of the thesis. Many thanks are due to Dr. A. H. El-Nasharty, Under-Secretary of State, Ministry of Agriculture, Egypt, for his great help in supplying some of the literature on the subject. The writer wishes to acknowledge sincerely the assistance of Mr. Roy W. Nixon, Horticulturist, U. S. Date Field Station, Indio, California, who also suggested presenting this paper at the 1962 Date Growers' Institute.

crop the following year, as examined in March 1956. This, as pointed out by Hilgeman (7), strongly indicates the importance of the presence of green functioning leaves for flower bud differentiation. If the series of leaves that have buds which would differentiate into inflorescences was interrupted by the removal of some intermediate leaves early or late in the season, would the series of flower buds be interrupted? Further studies were needed to answer this question.

The size of spathes before they appeared was relatively small until February, 1956, and most of the growth was confined to the spathe length. Most of the growth of spathes was made shortly before their opening.

Metaxenia

The direct effect of the pollen upon the growth and character of date fruit, aside from its effect upon the genetic composition of the embryo and endosperm of the resultant seed, has been experimentally confirmed by Nixon in 1925 (9).

The results of the present study agree with those obtained by Nixon. There were significant differences in size and weight of fruit and seed, resulting from different pollens. Figure 1 represents two extremes of fruit produced by two different pollens applied on the same bunch, on a Zaghloul palm. No striking marked effect was found, however, in time of ripening between the different treatments.

The post-bloom development

As mentioned before, measurements were made on detached fruits. Successive weekly samples

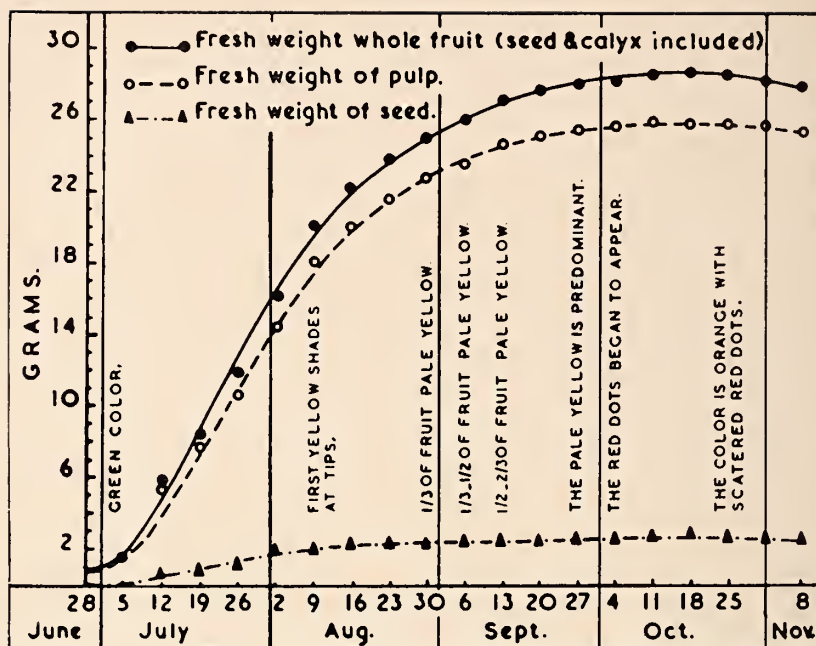


Fig. 2. Weekly changes in fresh weight of fruit (seed and calyx included), seed and pulp in the Samany date variety, 1956.

taken from each bunch is in fact a gradual process of bunch thinning. Previous studies, however, on attached and detached fruits agree with each other (3 and 6). Therefore, the results of the present study give an approximation of the changes which would occur in attached fruits.

Figure 2 shows the weekly changes in fresh weight of the fruit (seed and calyx included), seed and pulp, in the Samany date variety, 1956. It was found that most of the increase in size and fresh weight of fruit occurred during July and early August

(after 10 weeks from pollination). At such time the color was still green, and the increase in percentage of total soluble solids was very slight. It was also noticed that the rate of increase in size of both fruit and seed was more rapid than the increase in their fresh weight.

After 16 weeks from pollination, the percentage of total soluble solids decreased for a period of 3 weeks, at which time the seed began to harden, and the first shades of the final color were observed. This decrease in the per cent total soluble solids does not necessarily mean a decrease in the amount of soluble solids per fruit.

The rate of increase in size and weight of both fruit and seed slowed down after that period; and the rapid changes in color, the hardening of the seed, and rapid increase in the percentage of total soluble solids were the dominant changes.

After 27 weeks from pollination, the fruit reached its maximum size, weight and full color of the khalal stage (the horticultural ripening of the Samany variety in Egypt).

The size and weight of fruit decreased after that stage while the percentage of total soluble solids continued to increase. The fruit tips began to soften, and changed into a black color characterizing the rutab stage.

It should be mentioned that all these changes, especially in color, were more rapid in bunches facing sunlight for a longer period on any given palm. Furthermore, these changes were faster in fruits located



Fig. 1. Two extremes of fruit produced on the same cluster by two different pollens on a Zaghloul date palm in 1958.

I & II (middle) fruit sections and seeds of fruit shown at the right.
 III & IV (middle) fruit sections and seeds of fruit shown at the left.
 V (middle) seedless fruit resulting from pollination without fecundation.
 VI (middle) parthenocarpic fruit.

in the outer circles than those located in the middle of any given bunch.

The results obtained from the study of other varieties, namely, Zaghoul, Hayany and Bent Aisha and those of the previous 2 years, 1953 and 1954, showed a remarkable similarity to those of the Samany. However, there were some differences due mainly to variety and environment. The Hayany and Bent Aisha reached their full color of the khalal stage two or three weeks earlier than both the Zaghoul and Samany dates. Also, it was noticed that the weather was cooler during late summer in 1956 than the previous 2 years, resulting in slower changes, later time of ripening and leisurely ripening of fruits. Albert and Hilgeman (2) pointed out that differences in temperature are reflected in time of blooming and ripening of fruit.

The results presented with the 4 soft varieties grown in the coastal region of Egypt and those obtained in the U.S. with soft and semi-dry dates under the conditions of the Salt River Valley, Arizona (2) and Coachella Valley, California, (3, 6, 8 and 17), are in agreement that the post-bloom development of the date fruit, which is botanically a berry, follows the S-shaped pattern of growth. This is based on the changes occurring in size and weight of both fruit and seed. Such growth pattern is found in many other fruits, such as apples, pear, almond, avocado and strawberry. This is different from the behavior of stone fruits other than almond (e.g. apricot and cherry), and olive, which are botanically drupes. Such fruits, as indicated by Conners, Lilleland, Brooks, Hartmann and others, exhibit cyclic behavior characterized by a period of no increase in fruit size coinciding with endocarp hardening. In figs, Crane found that the fruit of both parthenocarpic (a fleshy peduncle) and non-parthenocarpic (the fleshy peduncle is lined with drupelets) varieties showed the cyclic growth behavior typical of the common drupaceous fruits.

Based on the rate of increase in total sugars, Rygg (17) suggested an intermediate stage of the post-bloom development of the date fruit, characterized by a considerable reduction in the already low rate of accumulation of total sugars coinciding with the hardening of the seed. It was found in the present study, as mentioned before, that the seed began to harden, and the fruit color began to change into a pale shade of the final color characteristic of the variety during the period of reduced percentage of total soluble solids.

These changes were consistent in all the four varieties during the 3 seasons of study.

PART II FRUIT THINNING

Most of the fruit thinning research of dates was carried out by Nixon since 1934, under Coachella Valley, California, conditions. Most of his work was concentrated on the Deglet Noor variety. Other experiments have been carried out by Nixon with other soft varieties; namely, Halawy, Barhee, and Medjool.

Up to the present time, bunch removal is the only method of fruit thinning used in Egypt. Furthermore, thinning is, in general, rarely practiced, and a continuous cycle of alternate bearing is, usually, prevalent in date palm plantings, and a large percentage of the fruit is far below the proper quality. But it will not be long before the producers will consider ways of producing dates of higher grades.

The purpose of the present study was to obtain some information about the best method and degree of fruit thinning that would result in higher grades of fruit and better time of ripening, and so might compensate for the decrease in total yield.

The Samany variety, which is one of the important soft dates, was chosen for these studies.

The Samany bunch is very large and characterized by long strands. The average number of flowers was 5,910 per bunch in this experiment. The fruit is of extra-large size. Therefore, when the percentage of fruit set is high, there is considerable crowding of fruit within the bunch and large variations in size and shape of fruit and in time of ripening are always observed.

A. METHODS OF FRUIT THINNING

MATERIALS AND METHODS

In 1954, twenty-five Samany palms, about 34 years old, were chosen for comparing the different methods of thinning. The palms were grown in one orchard in sandy soil in the coastal region of Egypt.

The following points were considered in choosing the trees: (a) vigor, (b) number of leaves, (c) number of bunches, (d) size of bunches and (e) apparent fruit set.

The experiment was carried out on June 10th, i.e. eight weeks after pollination. Fruit set was not recorded at time of thinning, but, in general,

Table 1. Effect of different methods¹ of fruit thinning on the different characteristics and crop weight in the Samany date variety, 1954.²

Average fresh weight per fruit (grams)	<u>E</u>	<u>D</u>	<u>B</u>	<u>A</u>	<u>C</u>
	29.64	30.73	31.88	34.16	34.93
Average fresh weight per seed (grams)	<u>D</u>	<u>B</u>	<u>E</u>	<u>C</u>	<u>A</u>
	2.60	2.60	2.63	2.65	2.66
Average fresh weight of pulp per fruit (grams)	<u>E</u>	<u>D</u>	<u>B</u>	<u>A</u>	<u>C</u>
	26.95	28.07	29.22	31.44	32.21
Average length of fruit (millimeters)	<u>E</u>	<u>D</u>	<u>B</u>	<u>A</u>	<u>C</u>
	52.07	53.21	55.59	57.50	57.51
Average largest diameter of fruit (millimeters)	<u>D</u>	<u>E</u>	<u>B</u>	<u>C</u>	<u>A</u>
	32.88	32.91	33.46	33.92	34.08
Average percentage total soluble solids in fruit	<u>E</u>	<u>D</u>	<u>A</u>	<u>C</u>	<u>B</u>
	24.45	25.33	27.81	27.91	28.12
Average crop weight per palm (kilograms)	<u>D</u>	<u>C</u>	<u>A</u>	<u>B</u>	<u>E</u>
	135.14	146.72	147.16	152.95	167.50

¹Methods of fruit thinning; 33% reduction:

- A Removing tips of strands
- B Removing central strands.
- C Removing tips and some central strands.
- D Bunch removal
- E No thinning (control).

²Underlining of mean values indicates significantly different populations as determined by Duncan's multiple range tests.

.....Significantly different, at the 5 per cent level.

——Significantly different, at the 1 per cent level.

Table 2. Effect of different degrees of bunch thinning on the different fruit characteristics and crop weight in the Samany date variety, 1956.¹

	D No thinning (control)	A Light 19% reduction	B Moderate 51% reduction	C Heavy 75% reduction
Average fresh weight per fruit (grams)	23.51	27.33	29.58	32.06
Average fresh weight per seed (grams)	2.30	2.47	2.76	2.86
Average fresh weight of pulp per fruit (grams)	21.14	24.79	26.76	29.14
Average fruit length (millimeters)	50.50	53.93	55.20	56.40
Average largest diameter of fruit (millimeters)	30.18	31.85	32.93	33.31
Average percentage total soluble solids in fruit	20.29	21.57	23.54	24.40
Average crop weight per bunch (kilograms)	30.24	27.00	19.68	13.65

¹Underlining of mean values indicate significantly different populations as determined by Duncan's multiple range tests.

.....Significantly different, at the 5 per cent level.

——Significantly different, at the 1 per cent level.

was below normal that year in all palms of the district due, possibly, to the late appearance of fruit spathes accompanied by hot weather. The sandy soil conditions of the district, may have been a factor involved.

Only nine bunches of nearly equal size and percentage fruit set were left on each palm for the studies.

The following four treatments, in which *one-third* of the fruits was removed, were applied.

Bunch thinning Treatment (A): cutting back the tips of strands. Treatment (B): removing entire strands from the center. Treatment (C): removing some entire strands from the center, and cutting back lightly the tips of the remaining strands.

Bunch removal Treatment (D): removing three bunches per palm.

Five palms were randomly assigned to each treatment and to the control (E). Except for the different thinning treatments, the palms were given the same cultural practices.

Dates were picked by a commercial picker on the following dates: October 22 and 29 and November 5, 1954. Samples of 50 dates were picked from each bunch on each palm at the first picking for measurements.

RESULTS AND DISCUSSION

Table 1 represents the results obtained by the different methods of thinning.

Comparing the different methods of fruit thinning as a means of im-

proving size and quality of fruit, bunch removal proved to be ineffective. There were no significant differences in size, weight of fruit, and the percentage of total soluble solids between bunch removal and no thinning. This method curtailed the yield per palm; the difference between thinned and the control, being significant at the 1% level.

Comparing the different methods of bunch thinning with bunch removal (Table 1), it was found that both treatments A (removing tips) and C (removing tips and some central strands) resulted in a highly significant increase in size and weight of fruit and pulp over bunch removal. These results agree with those obtained by Nixon with the Deglet Noor variety (12). It is evident that treatments A and C also resulted in highly significant increases in size and weight per fruit and percentage of total soluble solids over the control. Treatment B, on the other hand, was less effective than were both treatments A and C. There were significant differences in fresh weight of whole fruit and pulp (1% level), and fruit length (5% level) between both treatments A and C and treatment B.

Treatments A and C were approximately 2.0 and 2.5 times, respectively, as effective as treatment B in increasing the fresh weight of fruit and pulp. Both treatments A and C were as 1.5 times as effective as treatment B in increasing fruit length. In other words, treatments A and C which included the reduction

of number of fruits per strand were more effective in increasing the size and weight of fruit than treatment B which included the removal of entire strands.

Nixon compared different methods of bunch thinning in the Deglet Noor variety and found higher percentage of increase in fresh weight per fruit by removing tips than by removing strands (15). The percentages of increase were higher in Nixon's experiment than in the present experiment. This may be attributed to the higher percentage of thinning (50%) and earlier time of application (at time of pollination) in Nixon's experiment than in the present study.

Nixon found that a transverse notch cut made in the fruitstalk while the fruits were quite small, reduced the amount of growth made by the fruit. In other words, there is a limitation in cross-translocation of water and carbohydrates between the vascular elements leading to different strands within a fruitstalk (15). This emphasizes the importance of the number of fruits per strand in thinning long-strand varieties such as Deglet Noor and Samany.

Furthermore, since there is a tendency for better fruit set to occur at tips of strands, possibly due to more exposure to pollen, it seems that cutting back the tips increases the theoretical percentage reduction in number of fruits (11).

There was no significant difference in crop weight per palm between treatment B and the control. The difference was 14.55 kilograms which is 1.26 kilograms less than the 5% significant level. Treatments A and C curtailed the yield significantly at the 5% level. The reduction in crop was compensated for by the larger size and weight of fruit and the earlier time of ripening.

Although there were no significant differences between treatments A and C, yet it seems that removing some central strands reduces the compactness of the bunch, and prevents the accumulation, inside the bunch, of dropping fruits which rot and cause damage to other fruits.

The results indicate that thinning accelerated time of fruit ripening by two weeks as compared with the control. There was little difference, however, between time of ripening in the different thinning treatments.

B. DEGREES OF BUNCH THINNING

MATERIALS AND METHODS

The study of different degrees of bunch thinning was carried out in 1956 on palms of about 30 years

old, grown in a loamy soil in the coastal region.

Pollen from the same male was applied to each palm. One June 14, 1956, eight weeks after pollination, the bunches of every palm of the same age that were apparently uniform were examined for the number of strands, and percentage of fruit set. The set was examined in a sample of 25 strands per bunch. On the basis of such examinations four bunches of approximately equal size and percentage of fruit set were chosen on each palm. The number of strands was fixed, so as each bunch contained the same number of strands in every individual palm. Then the bunches were labeled at random for the four following treatments: Treatment (A) Light thinning: removing 10 per cent of the number of strands from the center, and in addition cutting back the tips of the remaining strands enough to remove about 10 per cent of their fruits, making a total reduction of about 19 per cent. Treatment (B) Moderate thinning: removing 30 per cent of the number of strands from the center, and cutting back the tips of the remainder enough to remove 30 per cent of their fruits, making a total reduction of about 51 per cent. Treatment (C) Heavy thinning: removing 50 per cent of the number of strands from the center, and cutting back the tips of the remaining strands enough to remove about 50 per cent of their fruits, making a total reduction of about 75 per cent.

The other bunches not included in the experiment were left on the palms, and all palms were given the same cultural practices.

Fruits were picked from the strands at weekly intervals on the following dates: October 7, 14, 21 and 28 and November 4, 11, 18 and 25. Samples were picked at random from every bunch at time of first picking for measurements.

RESULTS AND DISCUSSION

Table 2 summarizes the results obtained by the different degrees of thinning. The results indicate that the size and weight of Samany dates were increased in direct proportion to the severity of bunch thinning.

It was noticed in the previous experiment on the methods of fruit thinning, that there were no significant differences in the fresh weight of seed between the different treatments and control. Neither were there significant differences in the seed weight among treatments themselves in which one-third of the fruits was removed.

In the present experiment, there was a highly significant increase in

seed weight over both the control and light thinning (19% reduction) as a result of moderate thinning (51% reduction). There was no further significant increase in seed weight with further increase in the percentage of fruit thinning (75% reduction).

In other words, the increase in fresh weight of fruit was due to the increase in pulp weight. (Figure 3).

Comparing the different degrees of bunch thinning, it was found that light thinning resulted in a highly significant increase in size and weight of fruit over the control. It increased the fresh weight of fruit by 16.25% over the control. There was a significant difference in the percentage of total soluble solids at the 5% level. Light thinning resulted in a decrease of 10% in crop weight. This difference is significant at the 5% level. The increase in size and weight of individual fruit offset almost 50% of the percentage reduction in number of dates.

Moderate thinning proved to be more effective than light thinning in increasing size and weight of fruit and total soluble solids; the differences between them were significant at the 1% level. Moderate thinning gave an increase in fresh weight of fruit of about 10% more than in light thinning. This means that moderate thinning was 1.6 times as effective as light thinning in increasing fruit weight. It was also about 2.5 times as effective as light thinning in increasing the percentage of total soluble solids. On the other hand, moderate thinning curtailed the yield by about 25% more than light thinning did. The increase in fruit weight offset about 30% of the percentage reduction in number of fruits.

Heavy thinning resulted in a highly significant increase in size and weight of fruit over both light thinning and moderate thinning. It was 2.24 and 1.41 times as effective as light and moderate thinning, respectively, in increasing fruit weight. It was 3.2 times as effective as light thinning in increasing the percentage of total soluble solids. The difference was highly significant. There was no significant difference in the percentage of total soluble solids between heavy and moderate thinning.

Although heavy thinning was the most effective treatment in bringing about further advantages in quality and in accelerating ripening, yet it curtailed the yield more than the other two treatments. This treatment resulted in 55% reduction in crop weight per bunch. The increase in fresh weight of individual fruit offset about 25% of the percentage reduc-

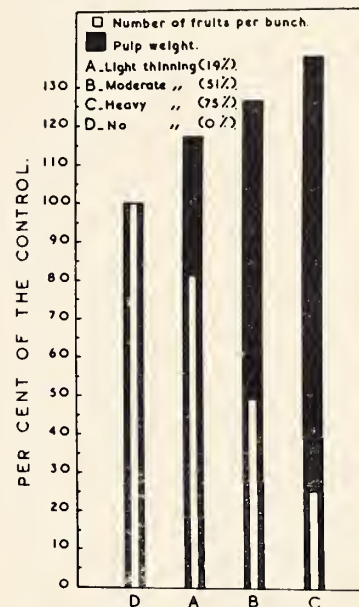


Fig. 3. Effect of degree of bunch thinning on fresh weight of pulp per fruit in the Samany date variety, 1956.

tion in number of fruit by bunch thinning.

Thinning accelerated time of fruit ripening in proportion to its degree. Figure 4 shows the percentage of crop harvested up to every picking in the different treatments. It is evident that heavy thinning was about 2 and 1 1/3 times as effective as light and moderate thinning, respectively, in accelerating fruit ripening. Similarly, moderate thinning was about 1 1/2 times as effective as was light thinning in accelerating fruit ripening.

It was found by Nixon (10 and 11), that the difference in time of ripening increased between the dif-

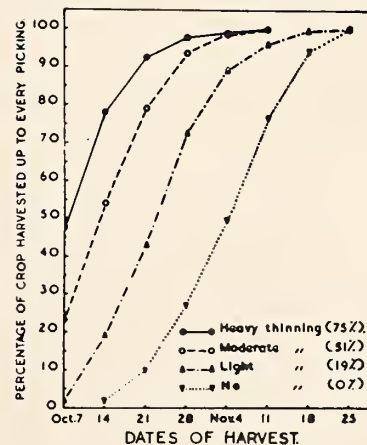


Fig. 4. Effect of degree of bunch thinning on time of fruit ripening in the Samany date variety, 1956.

ferent treatments as the season progressed, whereas the difference was about the same in the present study, when comparing the different percentages of the ripened fruits. This may be attributed to the cool weather at the time of ripening in the present experiment as was noticed in the study of fruit development which was carried out the same year.

SUMMARY AND CONCLUSIONS

Fruit development

The present study gives an idea about the nature of fruit development in dates under the conditions of the coastal region of Egypt. The results indicate the importance of the presence of green functioning leaves for fruit-bud differentiation. Concerning the direct effect of pollen (metaxenia), the results obtained are in agreement with those established by Nixon. Significant differences in size and weight of fruit resulted from different pollens. No striking differences were found, however, in time of ripening as a result of the application of different pollens. The results obtained during the study of the post-bloom development of four Egyptian soft varieties, Samany, Zaghloul, Hayany and Bent Aisha indicate that they follow the S-shaped pattern, based on changes in size and fresh weight of fruit. It was found that after 16 weeks from pollination, the percentage of total soluble solids decreased for 2-3 weeks, at which time the seed began to harden, and the first shades of the final color were observed. Environmental conditions, cultural practices, palm vigor and the percentage of fruit set are the most important factors affecting the rate of development. Furthermore, the rate of growth differs with the location of fruit on the bunch, and the location of the bunch on any given palm.

Fruit thinning

From the present experiments, it would be suggested that best results

in the Samany variety may be obtained from a thinning treatment in which about 35% of the fruit is removed in two steps.

The first is to cut back the tips of strands enough to remove about 20% of the total number of flowers, at time of pollination. The second step is to remove about 20% of the total number of strands from the center in June (approximately 8 weeks after pollination), when fruit set is evident and June drop has ceased. In years of heavy crop, this second step should include the removal of entire bunches. The bunches to be removed are the smaller ones which appear late in the season, and those of low fruit set. This second step, which includes bunch thinning and bunch removal, may be done at the time when the bunches are pulled down in the middle of June.

Such a method of fruit thinning should result in higher grade fruits and better time of fruit ripening, as found in the present experiments, which would compensate for the reduction in number of fruit. It should also insure an adequate crop the following year, in addition to the other advantages of fruit thinning.

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SAMPLING OF NEW DATE PRODUCTS

Hillman Yowell

California Date Growers Association
Indio, California

Coffee was served at the close of the meeting by ladies from the California Date Growers Association Packing Plant. Guests were invited

to sample freely from a large variety of date products in the form of baked breads, muffins, cakes, cookies and tarts. The Association has conducted

a research program to originate new and better products in which dates are a major ingredient.

MUTUAL COOPERATION BETWEEN F.A.O. AND THE SUDAN IN SOLVING DATE PROBLEMS

Frank H. Winter

Formerly with F.A.O. (Food and Agriculture Organization
of the United Nations)

This paper has two objectives: one, to explain the role of the FAO of the United Nations and two, to acquaint the date growers of the Coachella Valley with the problems of an underdeveloped country in building its date industry with the cooperation of FAO.

It is surprising how little is known of the various branches of the United Nations and perhaps at this time, during the troubled days of this World organization, it is fitting to discuss one of its functions. It is my hope that I can provide a somewhat better understanding by presenting some of the problems encountered, at least as far as dates are concerned.

FAO is the Food and Agriculture Organization of the United Nations and is dedicated to helping underdeveloped countries in improving their agricultural and food sources. It is not the American Aid plan known variously by the terms "Point Four", I.C.A., USOM, or AID, but is made up of peoples of many nations including the United States. No attempt will be made to explain the overall operations of FAO, but instead I shall stick to the division under which I have worked and with which I am familiar. This division, Agricultural Engineering, is concerned with many problems ranging from the improvement of hides and skins to the processing of edible oils and fruits and their by-products. When a country asks for aid in improving its industries in one of these fields FAO recruits a man for the time necessary to do the job and he is assigned to the Agricultural Engineering Division. We shall take the case of the Sudan, as this is the country with which I am most familiar, and trace through the development of their date industry.

In 1956 the Sudan asked FAO's assistance in developing their date industry, and what is important to realize is that they asked for "Technical Assistance" not money. They did not ask for equipment nor financial aid, but for cooperation. Although the recipient country normally pays a certain sum towards the expenses of the FAO representative who is sent by FAO to advise, and FAO pays a certain percentage, it very frequently happens that funds are

short and the recipient country pays the entire amount by putting up "funds in trust" and this is what the Sudan did for the first assignment.

I was asked by FAO to make a survey of the Sudan and at that time made certain recommendations. When the Sudan followed these recommendations I was assigned in 1957 and it is with the years from 1957 to the end of 1961 that this paper will be concerned.

The date growing areas of the Sudan lie along the Nile River beginning about two hundred miles north of Khartoum and extending to the Egyptian border. There are well over one million palms in this area which is hot and dry, resulting in dates of mostly drier varieties. Transportation and utilities in these areas are very poor. Electricity is non-existent in the main date growing areas, yet a considerable tonnage of dates (approximately 30,000 tons) comprises the main source of food and livelihood for its people, thus methods needed to be found to properly pack and process their dates. Infestation was one of the main problems as the insects prevalent in that always warm or hot area have perfect conditions for breeding and continuing their life cycles; date supplies saved for food literally disappear after the various insects attack them.

In addition to combatting the insect problem, the Sudanese also wanted to improve their processing and packaging in order both to attract new markets in their own and neighboring countries, and to give their own people clean and properly packed products. They wanted to develop date products not only to produce new and tasty foods but also to create an industry that would provide more jobs and better living conditions for their people.

The recommendations made to the Sudan at the time of my survey were that a pilot scale packing house with fumigation chambers be built in Kareima, a small town situated in the date growing area and some five hundred miles by river to the north of Khartoum. It was recommended that a well be dug for clean water and a generator be installed for power supply. Also recommended were simple washing, grading and packing machinery. The Sudan or-

dered and paid for all of the equipment and built the packing house according to the specifications. It is stressed that all of these costs were borne by the government of the Sudan and that nothing was contributed by FAO except the advice and recommendations.

So it was that in 1957, we had a good clean well with ample water, a 35 KVA generator for power, a packing house with screened windows to keep out insects and flies, and some simple grading and processing equipment. We had fumigation chambers, and one other important necessity—a people wanting to improve their conditions, wanting to learn, and in fact a people no different from the early pioneers of the Coachella Valley who tackled our own raw desert not so very many years ago. We of Kareima had the support of the Sudan government who encouraged us to go ahead and try to create a business that would be self-supporting.

At this stage I would like to say a word about the people of Kareima and the neighboring areas in the Northern Sudan. They are proud and hard working. What first strikes the traveler to this area is the fact that in spite of the intense heat the farmer is always out in the field. In the day time, from early morning to late in the evening, they and their families can be seen tilling the fields, irrigating and carrying on their never ending jobs. In the evenings and all night long the squeaking and grinding sounds of the saghias can be heard. These are the water wheels that elevate the waters of the Nile to the thirsty date palms. As the date growers of the Coachella Valley well know irrigation is tough enough without having to do it by primitive methods, so the efforts of the farmers along the Nile can be appreciated.

With the date growers striving to produce a crop that would give them a livelihood, and with a government willing to cooperate to the utmost, it was my earnest desire to do everything possible to improve packing methods and subsequently better living conditions for the people of the Northern Sudan.

The first efforts of the packing house were directed toward fumiga-

tion, not only at the packing house, but in the field. Mud chambers were built in the field, tarpaulins were used and fumigation chambers were constructed of whatever materials were available. The growers paid for the services given them and the funds received were put into the packing house revolving funds. Many of the merchants brought in their dates for fumigation in the early days and gradually as facilities improved the insect problem was brought fairly well under control.

The first grading efforts were most interesting. Girls were hired to do the grading and were provided clean uniforms and trained to keep the grading belts clean. The men who served as laborers, mechanics, and general helpers were also provided with uniforms and were well drilled in plant sanitation methods as well as insect and rodent control. It did not take long for all of the workers to develop a pride in their work and the weekly take home pay was quite a factor in the improvement of living conditions.

The first packing that was accomplished was with cellophane wrapped cartons, larger bulk corrugated cartons and in large poly-ethylene lined sacks for the bulk trade for the Sudan. These sacks were imported from Holland and proved to be very suitable for dry and semi-dry dates where cost factors were most important. The polyethylene inside liners not only kept the dates clean, but they made it possible to prevent re-infestation. Approximately 100 lbs. were packed per sack.

Surprisingly the small cartons sold very well throughout the Sudan, even in the smaller villages where the suqs (bazaars) were very small. The acceptance of packaged goods demonstrated the fact that people wanted a clean, neat product, so further experiments were made with a very small package of 75 grams (about 8 dates) that would retail for approximately 4 cents. This proved most popular with school children, at theatres, and all places of public

gatherings such as fairs or festivals, and resulted in a great deal of advertising.

As the operations of the packing house improved it gradually changed from a pilot scale operation to a full time commercial packing house. The growers soon began to realize that other products were a necessity in order to provide outlets for the by-products grades, so various types of date candies, jams, and other products were introduced. A still was set up for making spirits to be converted to vinegar, for medicinal purposes, and for de-natured alcohol. A modern vinegar generator was installed for the conversion and date vinegar proved to be quite popular. De-natured alcohol is a very big item in the Sudan as with very few towns having electricity, lighting is mainly by Tilley Lantern and Aladdin Lamp. These lamps burn kerosene under pressure, but it takes alcohol to start them hence the importance of de-natured alcohol.

As the Kareima Packing House developed, the Sudan government bought more and more equipment and extended its operations. It is planned that more packing houses will be built and especially more fumigation facilities now that the pilot scale plant has demonstrated that an industry could be created that would benefit the people. What is most gratifying at this stage is that the Sudanese are now running the packing house themselves and not only running it but doing a good job. A letter just received indicates that all of the tonnage handled by the plant last year has been sold and although this tonnage put through the packing house was only about two thousand tons, it was double the year before and was an effort made on a pilot scale operation only. As more experience is gained and as more packing houses are built, the Sudan hopes to eventually pack all of its dates in a modern manner, even though those dates still packed under the original methods are still being sold out year after year.

It has been stated that the Sudan has been selling its crop year after year and this may be surprising to some of the growers in the Coachella Valley, but more surprising is probably the price received by the growers. Every year prices to the growers start at about thirty five pounds a ton and shortly after harvesting rise to forty and even forty-five pounds per ton with an overall average of better than forty pounds to the ton. This converted to dollars and cents means that the grower of Sudanese dates receives close to six cents per pound for his crop, field-run, at the field and in CASH. Consignment is not followed in the Sudan, and the packer in order to get dates must pay out the cash. This is probably one of the stabilizing factors of date prices in the Sudan but other important factors are that dates are consumed as food and are the chief source of sweets to most of the peoples. The Sudan realizes however, that as more and more sugar is imported into the country, and as more and more other types of foods are developed, the date may not be in such favor. As it has happened in this country, where fresh fruits and candies make it difficult for us to market our dates at luxury prices, so will it be in the Sudan. For this reason, the Sudan is doing all it can to develop as many date-products as possible as well as to cut packing costs by modern methods of packing in preparation for the day when the dates become more and more difficult to market. The Sudan is dedicated to creating a thriving industry for its people and I believe they will accomplish this.

This then is the role of FAO and a small town along the banks of the Nile river. These are the date packing and marketing problems in another country. We have mentioned such items as irrigation saghias, date vinegar, and alcohol for kerosene lanterns, so it can be seen that in their own peculiar way dates lead to many a subject.



A TEST OF MATURE HALAWY AND MEDJOOL DATE PALMS FOR SALT TOLERANCE

By J. R. Furr and W. W. Armstrong, Jr.¹

Crops Research Division, Agricultural Research Service,
U. S. Department of Agriculture, U. S. Date Field Station,
Indio, California

The date palm has long been noted for its high salt tolerance. Swingle (9) observed that the date can endure more alkali (salt) than any other plant cultivated in the Sahara Desert, and Dowson (5) made a similar statement about the date in Iraq. Many general observations of the salt tolerance of the date palm may be found in the older writings on date culture, but only a little specific information is available regarding the effect on the palm of different salt concentrations in the soil. Swingle (9) reported the results of analyses of soil samples which he collected in several date gardens in Algeria in 1900. From these and other data available at the time he concluded that although the date can grow in soils containing 3 to 4 per cent of salts, it does not produce fruit unless some roots are in soil containing not over one per cent and that it does not yield abundant crops unless there are layers in the soil with less than 0.6 percent salt. He thought it probable that concentrations of salt below 0.5 percent of the soil do not exert an appreciable influence on the date palm. Brown (3), however, observed that in a district in Egypt where 0.13 to 0.22 percent chlorides occurred in soil at a depth of a meter and where water taken from a hole among the roots of the palms contained 33,080 parts per million (p.p.m.) of salts the palms were much less vigorous than those growing in non-saline soil. Studies (4) at Touggourt, Algeria, indicated that the date palm grew and fruited satisfactorily when the salt content (mostly chlorides and sulfates) of the soil solution was less than 15,000 p.p.m. and that it yellowed and was in danger between 15,000 and 30,000 p.p.m. The palms were dying where the salt content of the soil solution was 48,000 p.p.m.

In a survey in 1959 of soil salinity in date gardens in the Coachella Valley and the Chuckawalla Basin, California, Armstrong (1) obtained soil samples from the top 6 feet of soil in one garden that received yearly applications of 15 to 20 acre-feet per acre of water containing 4,000 to 6,000 p.p.m. of dissolved solids (salt). He found that the electrical conductivity of the saturation extracts (ECe) of about 1/3 of the

soil samples was greater than 10 millimhos per centimeter (mmhos/cm), at 25° C., that of several was greater than 20 mmhos/cm, and one sample had an ECe value of 45 mmhos/cm. The appearance of the trees indicated that the high concentration of salt in the soil had severely depressed growth. In testing Zahidi date seeds in sodium chloride solutions ranging from 0.1 to 2.5 percent, Khudairi (7) observed that germination was not affected by concentrations up to 0.8 percent (about 8,000 p.p.m.) and that germination occurred in solutions of increasing concentration up to 2 percent (about 20,000 p.p.m.).

In a classical study of the effect on plants of a wide range of salt concentration Eaton (6) observed that growth was reduced at concentrations at which no symptoms of injury occurred and that above very low concentrations of salt in the substrate growth gradually decreased with increasing concentration. No one concentration of salt could be established as the critical value at which injury occurred. In another fundamental investigation of the influence of salt concentration on growth of plants Magistad, Ayers, Wadleigh, and Gouch (8) showed that if salt concentration was expressed as atmospheres of osmotic pressure or as electrical conductance of the culture solutions, growth of a number of crop plants decreased in almost direct proportion as the concentration of chlorides or sulfates increased. Most plants tested showed little difference in the effect of solutions of chlorides and sulfates of equal osmotic pressure. The results of this and other investigations conducted by the staff of the U. S. Regional Salinity Laboratory at Riverside, California, form the basis of a standard method of studying the salt tolerance of plants growing in soil in the field.

The object of the test described in the present paper was to determine the effect of different concentrations of salts in the soil of the principal root zone of date palms on their growth and on the yield, size, and quality of the fruit.

MATERIALS AND METHODS

The method of measuring soil sal-

inity developed by the U. S. Salinity Laboratory (10) was used to follow the changes in salinity that occurred in the field plots on which the palms in this experiment were growing. For this measurement water was extracted by suction from a saturated soil sample, and the electrical conductivity of the saturation extract was measured with a conductivity cell and resistance bridge designed to give readings directly in millimhos per centimeter at 25° C.; these readings are often referred to as ECe values.

The experimental plots were on Indio loam 3 or 4 feet deep lying above stratified sand and thin silty or clayey layers that extended to a depth of at least 16 feet. The depth to the water table was not determined, but it was probably over 50 feet below the soil surface.

The trees were 17 years old and in full bearing at the start of the test in 1960. Each plot was 75x46 feet and contained 2 trees, 1 Halawy and 1 Medjool. The salt plots extended across two rows to within a few feet of the rows of border palms that ran along each end of the plots. Single rows of border palms also ran between the plots in an unirrigated strip about 14 feet wide.

The two control plots received only Colorado River water from the Coachella Valley Branch of the All-American Canal. One of the control plots contained the 2 trees at the head of the irrigation run (trees No. 1 in adjacent rows); and the other control plots, 2 trees at the lower end of the run (trees No. 9). Border palms surrounded the No. 1 control trees, but were on only 3 sides of the No. 9 control trees. The 3 salt treatments were applied to single plots. While the design of this experiment was admittedly defective, neither trees nor facilities were available for replication of the large salt plots required if mature palms at the usual spacing of 30 feet were to be used.

The soil of the salt plots was salinized by applying sodium chloride and calcium chloride in approxi-

¹ Present address: Department of Fruit Production, California State Polytechnic College, Kellogg Campus, Pomona, California.

mately equivalent amounts directly to the soil surface just before each application of water from May 19 to December 14, 1960, and from March 9 to November, 1961.

The treatments consisted of 3 levels of salt concentration in addition to the very low level maintained in the control plots by the use of canal water, which had a conductivity of about 1.4 mmhos/cm at 25° C. The approximate salinity levels maintained in the salinized plots were equivalent to the following conductivities of the saturation extracts of the soil at 25°: low, 4-6 mmhos/cm; medium, 8-12 mmhos/cm; high, 16-24 mmhos/cm. To maintain these ECE values, it was necessary before each application of water to add approximately the following amounts of calcium chloride and sodium chloride, respectively, to the plots: low, 120 lb. and 100 lb.; medium, 240 lb. and 200 lb.; high, 560 lb. and 450 lb.

Two days before each application of water and salt the soil of all plots was sampled to a depth of 8 feet: the top 4 feet at intervals of 1 foot; the lower 4 feet at intervals of 2 feet. From the ECE values of these samples the amounts of salt needed to maintain the proper salinity levels were estimated. Once the proper levels were attained, there was little difficulty in maintaining them.

Irrigation water was applied at intervals of about 1 month in winter, 2 weeks in spring and fall, and 1 week to 10 days in summer. This schedule kept the soil moisture high in all plots, so that soil moisture deficiency probably did not affect tree growth. The total yearly application of water was about 10 acre-feet per acre.

As a measure of growth, the rate of elongation of 1 or 2 leaves on each test tree was determined from weekly measurements. From these data the relative growth rate of each tree in the salt plots was calculated as percent of the average growth of the control trees (growth index).

The total yields were obtained by weighing picked fruit, windfalls, and culls from each tree. Fruit size was determined by counting and weighing several hundred fruit per tree at each picking.

Table 1. Salinity levels of the soil under the different treatments as shown by the averages of the ECE values at different depths.

Treatment	Tree No.	1960		1961	
		Depth-feet		Depth-feet	
		0.4	4.8	0.4	4.8
Control	1	2.6	3.2	3.8	3.5
Low	3	5.9	4.9	7.2	6.4
High	5	16.0	10.9	23.3	23.8
Medium	7	9.4	8.2	11.7	11.0
Control	9	2.9	3.7	2.9	4.0

Table 2. Relative rate of leaf growth of Halawy and Medjool palms in relation to soil salinity.

Period	Leaf-growth indices ¹						Salinity status
	Medjool			Halawy			
	Treatment:			Treatment:			
	Low	Medium	High	Low	Medium	High	
4/15/60 - 5/16/60	101.7	102.9	101.7	100.4	89.3	83.0	not salinized
5/16/60 - 11/14/60	90.1	91.6	84.9	92.8	82.6	82.6	salinized
11/29/60 - 3/6/61	91.7	90.1	88.4	87.0	78.4	70.3	not salinized
3/6/61 - 6/27/61	90.4	90.8	88.4	84.4	lost	75.6	salinized
6/27/61 - 9/11/61	88.3	95.6	91.0	89.2	92.0	80.3	salinized
¹ Leaf-growth indices: average leaf growth of Halawy and Medjool controls, respectively, = 100							

¹Leaf-growth indices: average leaf growth of Halawy and Medjool controls, respectively, = 100

On August 31, 1961, shortly before the termination of the experiment, pinna samples were taken from the 3 youngest mature leaves on each tree and from the 3 youngest leaves that subtended fruit bunches. The pinnae were dried and analyzed for chloride by a modification of the method described by Brown and Jackson (2).

RESULTS AND DISCUSSION

The ECE values obtained from the large numbers of soil samples taken during the periods when the salt plots were salinized (May to December 1960 and March to November 1961) were averaged to show the approximate salinity levels of each plot at depths of 0-4 feet and 4-8 feet. These data (Table 1) show that, in general, the concentration of salts in the salinized plots was appreciably higher in 1961 than in 1960. Because of the apparent slight effect of the salt treatments in 1960 the salinity levels were purposely raised to fall near the upper limits of the ranges selected from the different treatments. The ECE values of samples from the control plots show that even with rather copious applications of irrigation water sufficient salt accumulated to give ECE values about 2 or 3 times that of the canal water. This is the usual situation found in the loam soils in the Coachella Valley.

Leaf-growth rates were determined for a month before salinization of the plots in 1960 and also for about 3 months in the winter of 1960-61, when only canal water was applied to the salt plots and most of the salt was leached out of the soil in the top 8 feet, the principal root zone

of the palms. Leaf-growth indices (Table 2) do not clearly show whether the apparent reduction in leaf-growth rate which occurred in the period May 16 to November 14, 1960, was caused by the increase in salinity of the salinized plots. The leaf-growth indices of all trees for the entire period of the experiment considered together, however, clearly indicate that little relation existed between the level of soil salinity and the rate of leaf-growth. Though leaf-growth rate may have been affected slightly by salinity, the decrease in relative rate was too small to detect in non-replicated plots.

Since the salt treatments were applied in 1960 after the fruit had set, if the salt treatments had affected the yields, the effect would probably have been a decrease in weight per fruit resulting either from a reduction in size or from drying. The variations in fruit size in 1960 (Table 3), however, do not appear to be consistently related to either salt treatment or total yield of the trees. In 1961 the total yield per tree seemed to be related more closely to the previous year's yield or to position of the tree in the row, that is, to light exposure, than to salt treatment. Fruit size likewise was not clearly related to salt treatment. The smallest Halawy fruit was from the high-salt plot, but the largest Medjool fruit was also from the high-salt plot.

The 1961 harvest yielded abnormally high amounts of khalal and partly ripe Halawy fruits and also large amounts of Medjool fruit that was graded as hard-end and shrivel or that shattered from the bunch in the khalal stage. We thought these large amounts of undesirable fruits were perhaps related to the salt treatments, and therefore no field culling was done, but the entire crop was harvested and large representative sub-samples were removed and graded in the packinghouse.

The percentages of normal fruit (Table 4) of both varieties were remarkably similar regardless of variations in salinity of the soil on which they are grown. The high percentages

of khalal and partly ripe fruit that fell from bunches of the Halawy palms at the time of harvest in the medium and high-salt plots suggest a possible relation to treatment, but there was no apparent relation between the amount of abnormal Medjool fruit and soil salinity.

No leaf-burn or other symptoms of salt toxicity were observed on any of the palms during the experiment. Chemical analyses for chlorides in pinna samples from young and old leaves (Table 5) show that there was apparently little or no relation between the percentage of chlorides in the leaves and the salt concentration of the soil on which the trees were growing. In comparison with such salt-sensitive plants as citrus trees, the palms had very low percentages of chlorides in the leaves. Unless chlorides accumulated in parts of the trees other than the leaves and were not translocated to the pinnae, the pinna analyses indicate that chlorides were not taken in with the water absorbed from the soil, but were largely excluded by the roots. The root systems of mature date palms are extensive, and it is highly probable that some roots extended beyond the salinized plots into soil low in salt. Most of the roots of the palms in the salt plots must, however, have been confined to the salinized areas, and most of the water absorbed by the trees in the salinized plots must have been from salinized soil.

The results of this experiment indicate that the ability of the date palm to exclude chlorides in the process of absorbing water from highly saline soil is an important factor contributing to the high salt tolerance of the date palm.

SUMMARY

In a study of the effect of variations in soil salinity on mature Halawy and Medjool date palms those on non-salinized control plots with an ECe range of 2-4 mmhos/cm at 25° C. were compared with palms on plots salinized with equivalent amounts of calcium and sodium chlorides to the following ECe ranges: low 4-8; medium 8-12; high 16-24. The variations in salinity apparently had little or no effect on growth rate of leaves, on yield, size, or quality of fruit, or on chloride content of the leaf pinnae. Apparently the ability of the date palm to exclude chlorides during the process of absorbing water from highly saline soil is an important factor in its high salt tolerance.

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Table 3. Total yield per tree and average weight per fruit produced by Halawy and Medjool palms in relation to soil salinity.

Treatment	Tree No.	Halawy				Medjool			
		1960	1961	1960	1961	1960	1961	1960	1961
		Yield (lbs.)	Wt. per fruit (gms.)	Yield (lbs.)	Wt. per fruit (gms.)	Yield (lbs.)	Wt. per fruit (gms.)	Yield (lbs.)	Wt. per fruit (gms.)
Control	1	291.0	8.7	409.0	8.5	249.8	18.6	310.0	23.0
Low	3	436.5	7.7	395.5	8.6	248.3	18.1	323.0	21.6
High	5	381.5	7.9	279.0	7.7	172.5	17.9	213.3	23.6
Medium	7	265.0	8.4	309.5	8.5	280.0	14.2	208.0	23.2
Control	9	371.5	8.3	432.5	9.3	265.8	15.9	412.5	20.8

Table 4. Percentages of different grades of fruit produced in 1961 by Halawy and Medjool palms in relation to soil salinity.

Treatment	Tree No.	Halawy			Medjool			
		Normal	Khalal and part-ripe	Culls	Normal	Hard-end and shrivel	Khalal shatter	Culls
Control	1	79.1	13.1	8.0	75.7	2.5	9.7	12.1
Low	3	82.1	14.8	3.1	72.1	14.3	6.4	7.2
High	5	75.2	22.9	1.9	76.5	10.8	7.4	5.3
Medium	7	74.9	21.2	3.9	76.6	6.6	10.7	6.1
Control	9	78.8	13.0	8.2	69.0	13.1	6.9	11.1

Table 5. Percentage of chlorides in dry pinna samples from young and old leaves of Halawy and Medjool palms in relation to soil salinity.¹

Treatment	Tree No.	Halawy		Medjool	
		Young leaves	Old leaves	Young leaves	Old leaves
Control	1	0.70	0.62	0.77	0.63
Low	3	0.85	0.55	0.82	0.70
High	5	0.77	0.53	0.91	0.69
Medium	7	0.76	0.54	0.85	0.87
Control	9	0.87	0.43	0.80	0.67

¹Chloride percentages are averages of duplicate analyses.

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CONCENTRATIONS OF NUTRIENTS IN PINNAE OF DATE PALMS IN RELATION TO AN UNEXPLAINED DIE-BACK OF LEAVES IN COACHELLA VALLEY, CALIFORNIA

By C. K. Labanauskas and R. W. Nixon

University of California Citrus Research Center and
Agricultural Experiment Station, Riverside, California, and
U. S. Department of Agriculture Date Field Station,
Indio, California, respectively

Concentrations of nutrients in the pinnae of date palms were determined in an attempt to find the cause of a die-back of leaves that has occurred on a few palms in the Coachella Valley of California. Some data on the mineral composition of date leaves have been reported (1, 3, 5, 6, 7, 9), but studies in this field have not been carried far enough to provide a background for evaluating the nutrient status of date palms by foliar analysis. Current fertilization practices have been evolved from observations, experience, and field trials. In the Coachella Valley nitrogen, applied either as manure or chemical salts, is the only element to which there has been any apparent response (4). While results from nitrogen fertilization in many cases appear satisfactory in terms of yield and quality, there is considerable uncertainty as to optimum amounts and time of application.

Whether elements other than nitrogen, especially the micronutrients, are involved in some of the abnormal palm conditions reported from time to time, is not known. The increasing use of leaf tissue analyses as a means of diagnosing the mineral-nutrient status of fruit, nut, and ornamental plants in southern California suggests that this approach should be made in date culture.

The present report presents the nutrient concentration values found in the pinnae of leaves of date palms growing in southern California. No attempt, however, was made to determine the critical levels of the nutrients in the pinnae or the nutrient requirements of date palms growing under conditions different from those in this limited survey, but, values from vigorous palms were compared with those from palms affected with a disease of unknown cause.

MATERIALS AND METHODS

Observations:

In 1959, D. H. Mitchell noticed some dead leaves in the crowns of several young date palms in a garden located about a mile north of Palm Desert in Coachella Valley,

California, and the following spring he called this abnormal condition to the attention of the U. S. Date Field Station. Examination of the trees on June 29, 1960, showed that the die-back of leaves was confined to a selected seedling palm about 10 years old and 16 feet high to the bud and to 10 young palms about 5 years old and 3 to 6 feet high, representing off-shoots from the mother palm.

On the mother palm, about midway between youngest and oldest leaves, 3 or 4 leaves had died back from the tip for about $\frac{1}{4}$ to $\frac{1}{2}$ of the blade length. On the younger progeny palms about half of the leaves had died back from the tip for about $\frac{1}{4}$ to $\frac{9}{10}$ of the blade length. These partially dead leaves on the younger palm trees were scattered through the crown with green leaves interspersed. Other palms in adjacent rows on either side of the affected palms did not show such symptoms.

The affected palms were observed from time to time during the growing season of 1961. Some new leaves on the young affected palms showed fading of green tissues soon after emergence, but the necrotic areas in the older leaves remained about the same.

In the spring of 1961 the affected palms were examined by two plant pathologists, E. F. Darley, of the Citrus Research Center and Agricultural Experiment Station, Riverside, California, and J. B. Carpenter, of the U. S. Date Field Station, Indio. Both were of the opinion that it is highly improbable that any disease-producing organism is involved. The next logical approach was to explore the possibility of some nutrient deficiency or excess.

Sampling and Treatments

On April 5, 1961, leaf samples were taken from one of the affected palms and from three adjacent palms representing three commercial varieties. Sampling consisted of selecting three leaves approximately 1 to 2 years old. From each leaf 15 pinnae were taken: five near the tip of the rachis, five near midblade, and five

near the base. These 45 pinnae per palm were composited.

Additional pinna samples were taken on May 9, 1961, from one of the affected palms and from 5 other palms representing 4 commercial varieties which did not show any symptoms. No macro or micronutrient foliage sprays had been applied.

On April 5, 1961, 10 lbs. of $MnSO_4$ was applied to the soil around one of the affected palms, 5 lbs. of NH_4NO_3 to another palm, and nothing to one palm left as a control. In addition to these treatments, on July 11, 1961, 2 lbs. of borax was applied to the soil around one of the affected palms and an adjacent palm was left as a control. On August, 1961, pinna samples were taken from the treated palms and a control. As soon as the samples were collected, they were hand-washed in tap water containing aqueous solution of one percent detergent, rinsed in demineralized water, and dried in a forced-draft oven at 60° C. When dry, the pinnae were ground in an 8-inch Christy-Norris laboratory mill, and weighed portions of this ground material were ashed at 500° C. Methods of analyzing the pinnae for N, P, K, Ca, Mg and Cl were those used by Embleton et al. (2), and methods for determination of Zn, Cu, Mn, B, and Fe were those used previously by Labanauskas et al. (8).

Results and Discussion

The data obtained from chemical analysis of pinna tissue are summarized in Tables 1 and 2. Since the pinnae sampled at different dates were approximately of the same age, and the values obtained from the chemical analysis of tissue did not differ greatly, only the means of different sampling dates for individual varieties are presented.

From the values presented in Tables 1 and 2 it is evident that the mineral concentrations of all elements in pinnae of the seedling variety affected with die-back were within the range of those in normal healthy palms of other varieties, growing nearby or in other date gar-

Table 1.—Macro- and micronutrient concentrations in oven-dried pinnae of leaves from date palms growing in Coachella Valley, California.

Variety	percent						ppm				
	N	P	K	Ca	Mg	Cl	Zn	Cu	Mn	B	Fe
Deglet Noor	1.54	.096	.71	.60	.132	.50	9	4	70	22	89
Halawy	1.55	.120	.70	.51	.180		16	5	74	10	106
Khadravy	1.37	.089	.47	.49	.196	.53	10	5	26	12	122
Medjool	1.55	.110	1.30	.60	.090		6	4	51	10	87
Sayer	1.23	.086	.43	.60	.229	.61	15	5	40	24	83
Tabarzal	1.18	.095	.96	.52	.103	.66	7	4	24	21	77
Seedling Variety ^a	1.30	.112	.49	.84	.117	.50	10	4	61	21	110
Mean	1.40	.101	.72	.59	.150	.56	10	4	49	17	96

^a Variety which showed die-back of leaves.

Table 2.—Micronutrient concentrations in oven-dried pinnae of leaves from date palms one month after treatment with borax, ammonium nitrate, and manganese sulphate.^a

Treatment	ppm				
	Zu	Cu	Mn	B	Fe
None	12	2	43	114	92
Borax, 2 lbs.	10	3	42	119	113
NH ⁴ NO ³ , 5 lbs.	11	3	41	88	112
MnSO ⁴ , 10 lbs.	10	3	73	114	133
Mean	11	3	50	109	112

^a Pinnae from seedling variety showing die-back symptoms.

dens in Coachella Valley. The low boron content for all varieties in samples taken in April and May as compared with the considerably higher concentration for the die-back palms in samples taken in August may reflect seasonal differences. In any event, the higher concentrations of boron in the later samples are within the range of those reported by Haas (5). There is no indication, therefore, that this die-back of date leaves is related to a deficiency or an excess of any of the elements listed.

On the other hand, because of the small number of samples involved, no definite conclusions should be drawn from the data summarized in Tables 1 and 2 as to whether the date palms are adequately or inadequately supplied with the macro- and micronutrients. Data must be obtained from a much larger number and range of samples with uniform techniques of sampling before tentative standards can be established for the evaluation of the nutrient status of date palms on the basis of leaf analysis. Differences among varieties must also be taken into account (6).

While awaiting the development of such criteria for the date palms, it may be of value to compare the data

presented in Tables 1 and 2 with tentative standards for classification of the nutrient status of Valencia orange trees based on leaf analyses found in the literature (10). Such a comparison made it apparent that the pinnae from date leaves contained somewhat lower concentrations of nitrogen, phosphorus potassium, calcium, magnesium, zinc, and copper, and higher chloride, manganese, and iron than 5-to 7-month-old Valencia orange leaves from trees growing in coastal and intermediate valley regions of California. Obviously these difference have only suggestive value because of differences in types of plants, soil, and age of leaves.

The fact that palms of only one variety were simultaneously affected with similar symptoms suggests that this disorder may be of a genetic origin. This hypothesis is supported by the fact that similar leaf die-back occurs among a few seedling palms in the date breeding plot at the U. S. Date Field Station: five seedlings in one location and three in another, progeny of one minor variety. In both locations some of the palms have pronounced leaf die-back, whereas seedlings of other varieties on all sides are normal. Another pos-

sibility, of course, is that the die-back might be a seed-transmitted virus disease.

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FREQUENCY OF PICKING IN RELATION TO QUALITY OF DEGLET NOOR DATES IN 1961

By Roy W. Nixon and J. R. Furr

Crops Research Division, Agricultural Research Service,
U. S. Department of Agriculture, U. S. Date Field Station,
Indio, California

Introduction

Studies of frequency of picking in relation to quality of Deglet Noor dates begun in 1960 (1) were continued in 1961, again in cooperation with the California Date Growers' Association and the Valley Date Gardens, Inc. The number of date gardens included was increased and current practices of harvesting all ripe fruit on the palm in 2 or 3 pickings was compared not only with one picking for the entire palm but also with harvesting all the fruit from a single bunch at one time but not necessarily all the bunches at one time. In gardens where the fruit ripened early and rapidly all bunches were harvested at the same time but in others where there was a greater spread in ripening, fruit was picked 2 or 3 times and only those bunches which had all, or nearly all, the fruit ripe were harvested.

The study was also extended to cover field culls—fruit which either fell from the bunch during the harvest and was not retrieved for the packing house, or was deliberately discarded by the picker. Packing houses have encouraged culling by the picker because packing house culling is more expensive and the grower has sometimes been penalized for excessive culls in delivered fruit.

Experimental procedure.

Studies were carried out in 7 gardens in different parts of Coachella Valley, California. In each garden there were 10 two-tree plots; 5 replicates of each of 2 randomized treatments. In 3 gardens (A, B, and C) harvesting in 2 regular pickings was compared with harvesting all the crop in 1 picking. In 4 gardens (E, F, G, and H) harvesting in 2 or 3 regular pickings was compared with harvesting entire bunches in 1 to 3 pickings.

Fruit picked from each plot was recorded separately and subsamples were taken from each lot at the packing house and graded as top natural, select natural, semidry, standard dry, and culls. Such grades determine payment for each lot of fruit delivered to the California Date Growers' Association.

Field culls are customarily gathered in lugs and left in the field for

buyers, who currently use them either for mixing with stock feed or for making industrial sirup. The weight of field culls from each plot was estimated from the number of lugs at time of picking; then samples were taken by hand, a few pounds at random from each lug, and delivered to the U. S. Date Field Station for inspection. From 100 to 150 representative dates from each plot were graded and the percentage of culls resulting from different sources determined by count rather than by weight because this affords a better evaluation of the loss from each source. One plump date culled because of immaturity, rot, or insect damage might weigh as much as 3 or 4 culled because of shrivel or bird pecks, but if such dates had not been culled there would not have been much difference in weight between them and the culls of other kinds.

Results and Discussion

In gardens A, B, C, and E the fruit ripens relatively early; in F a little later; in H still later; and in G latest of all. In gardens A and E the first picking was the last week in September and the last picking the last week in October. In garden G the first picking was the middle of November and the last the first week

of February. Gardens G and H are in the west end of Coachella Valley and the others in the central and southeastern portion. The distance between the most westerly and the most easterly gardens is about 30 miles.

In the 3 gardens where 2 regular pickings were compared with 1 picking, the results (Table 1) closely parallel those reported for 1960 (1). A significant decrease in natural grades resulted from harvesting all the crop in one picking.¹ The significantly higher percentage of culls in the single picking in garden C was attributed chiefly to higher insect infestation.

In the 4 gardens where regular picking 2 or 3 times was compared with harvesting entire bunches 1 to 3 times grades differed little. The average percentage of top natural fruit was significantly higher in regular picking, but the difference was not large and was not accompanied

¹Grateful acknowledgment is made to E. J. Koch of Biometrical Services, Agricultural Research Service, U. S. Department of Agriculture, Beltsville, Maryland, for the statistical analysis of the data reported in Table 1.

Table 1. Effect of frequency and method of picking on percentage of different grades of Deglet Noor fruit*

Garden and Picking treatment	Top Natural	Select Natural	Semidry	Standard Dry	Culls
A: Regular	5.0a	24.4a	48.5a	19.3a	2.8a
A: Single	.8b	10.0b	54.8a	31.6a	2.8a
B: Regular	2.3a	12.4a	57.6a	23.9a	3.8a
B: Single	.0a	2.6b	52.8a	37.8a	6.8a
C: Regular	9.2a	21.2a	40.9b	25.4a	3.3b
C: Single	.0b	5.4b	58.4a	27.0a	9.2a
A, B, C: Regular	5.5a	19.3a	49.0a	22.9a	3.3b
A, B, C: Single	.3b	6.0b	55.3a	32.1a	6.3a
E: Regular	.9a	12.7a	64.8a	18.0a	3.6b
E: Bunch	1.6a	13.6a	51.0b	24.2a	9.6a
F: Regular	5.1a	25.7a	46.2a	15.7a	7.3a
F: Bunch	4.3a	22.5a	46.0a	16.9a	10.3a
G: Regular	14.6a	49.5a	25.6a	5.0a	5.3b
G: Bunch	9.4b	44.9a	29.1a	3.2a	13.4a
H: Regular	6.8a	21.6a	62.5a	5.3a	3.9b
H: Bunch	7.2a	23.8a	56.1a	6.4a	6.5a
E, F, G, H: Regular	6.8a	27.4a	49.8a	11.0a	5.0b
E, F, G, H: Bunch	5.6b	26.2a	45.6a	12.6a	10.0a

*Values not followed by the same letter are significantly different at the 5% level.

by significant difference in the select natural grade, the larger of the 2 natural grades. In each of the 4 gardens the percentage of packing house culls was higher in bunch harvesting than in regular picking. This was explained by the fact that some bunches had immature fruit. Further drying and some consequent reduction in percentage of natural fruit would be expected from further delay in bunch harvesting, but it is unlikely that this reduction would be nearly as large as when no picking is done until all the fruit is ripe.

Field Culls

Field culls, which were not included in the total of picked fruit recorded at the packing house, account for 5 to 10 percent of the total yield (Table 2). This is a much lower proportion of the crop than in 1960, when field culls were 21 to 46 percent of the total yield in the 2 gardens for which records were obtained (1).

The average of field culls was higher in regular picking than in either of the other 2 methods of harvesting, but there was considerable variation between gardens and some uncertainty as to uniformity of handling. In 1960, one of the gardens had a much higher percentage of field culls when the crop was harvested in 1 picking than when it was harvested in 2; the other garden showed no difference between 1 picking and 3 pickings. One possible reason why there were more field culls in the regular picking in some gardens is suggested by the conditions under which fruit rot occurred in 1961.

In the regular pickings in all 7 gardens, a higher percentage of field culls resulted from fruit-rot than from any other cause (Table 3). The per-

centage of rotten fruit was much higher in the first picking than in later ones. The incidence of rot was traceable for the most part to rain and humid weather which occurred in August, but which ended abruptly the later part of that month and was followed by a dry rainless period of three months. Without exception, however, more fruit-rot was recorded among the field culls in the regular picking than in either of the other 2 methods of harvesting. One possible explanation is that when picking was delayed until all the fruit on the palm or a given bunch was ripe, probably some of the rotting fruit which dropped to the ground was not subsequently gathered and recorded. A second possibility, based on observations in years past, is that very slight or incipient fungus infections, just beginning in August, were checked by the sudden break in the weather and the following period of low humidity. Such fruit, which might have shattered if the bunch had been handled by early picking or might have been discarded by the picker as a suspected cull at that time, may later have ripened and cured normally.

An unexpected finding was that about ¼ of the field culls were good dates. This is a large percentage. The much higher percentage of good fruit found in the field culls in bunch harvesting than in regular picking apparently resulted from opening and shaking the bunches before harvesting. This practice, often followed when fruit-rot is present in the bunches, was apparently overdone in this case. Fully ripe fruit shatters more readily than less mature fruit. All fruit shaken off was put in the field culls.

The third most important source of field culls was shrivel, which ac-

counted for almost 1/5 of the total except in the single picking treatment in gardens A, B and C where twice as much shrivel occurred as in the other treatments. The delay in picking in these 3 gardens, where the fruit matured early during hot dry weather, resulted in excessive drying. The reddish color of the shriveled fruit indicated that most of the shrivel occurred in the khalal stage. None of the fruit had enough flesh to be marketed. The smaller and light-colored fruit that shriveled in the green stage, some of which was included in the samples taken in the field, was discarded and not included in the record.

Field culls caused by insect infestation were less than 5% in gardens A, B and C and somewhat higher in the other 4. This may reflect differences in the use of insecticides. In all gardens where the harvest extended beyond November and where more than 1 picking was made there was a marked decrease in the percentage of infested dates in the later pickings. This may be illustrated by the record in garden G where the percentages of field culls due to infestation at the first, second and third regular pickings were, respectively, 3.3%, 0.2%, and none; and at the first, second and third bunch harvests, were, respectively, 5.6%, 0.5% and none. Insect pests prefer ripe to immature fruit and become less active with the lower temperatures of fall and winter.

Other sources of field culls did not appear to bear any relation to the frequency or method of harvesting, except possibly the slightly higher percentage of immature (khalal) fruit in the regular picking, which might be expected when the bunches are handled more than once. A few unpollinated dates occur sporadically in all gardens. The percentage of fruit culled because of dirt, which usually results from contact with the soil or from mashing the date in handling, might be taken as an index to care in handling. Among "other" sources of field culls were blacknose, black scald, and deformities, which were of little consequence in 1961.

Summary

For the second season, dry much like the previous one, harvesting all Deglet Noor fruit in 1 picking rather than in 2 regular pickings resulted in a decrease in natural grades and an increase in semidry and dry grades. There was relatively little difference in the effect on grades between regular picking (2 or 3 times) and harvesting entire bunches (1 to 3 times), but a higher percentage of culls resulting from immature fruit

Table 2. Average yield of Deglet Noor fruit per garden (10 palms), including field culls, in relation to frequency and method of picking.

Gardens and number of pickings	Fruit picked (lbs.)	Field culls (lbs.)	Total yield (lbs.)	Field culls (%)
A, B, C: 2	2619	275	2894	9.5
1	2815	156	2971	5.3
E, F, G, H: 2-3	3051	349	3400	10.3
1-3*	3056	280	3336	8.4

* Entire bunches

Table 3. Percentage of field culls of Deglet Noor dates from different sources.

Gardens and picking treatment	Good Fruit	Fruit rot	Shrivel	Insect Damage	Imma- turity	Dirt	No pol- lination	Bird pecks	other
A, B, C*: Regular	29.9	33.7	19.5	3.6	3.1	2.5	2.8	1.0	3.9
Single	25.4	9.8	40.6	3.4	2.8	3.0	6.0	4.7	4.3
E, F, G, H*: Regular	21.3	32.2	17.8	5.7	6.6	7.2	3.8	2.4	3.0
Bunch	44.3	18.2	16.1	9.5	3.2	3.0	2.1	0.8	2.8

* Average for these gardens

was evidence that some entire bunches were harvested too soon.

Field culls, fruit that dropped during harvest or was discarded by the picker and not taken to the packing house, were examined from all plots

and found to be chiefly good fruits or those affected by fruit-rot and shrivel. All other sources of field culls, including insect infestation, immaturity, and lack of pollination, accounted for only about one-fourth of the total.

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REMARKS ON THE MECHANIZATION OF DATE HARVESTING

By **Billy J. Peightal, Manager**
Date Administrative Committee
Indio, California

Mechanizing date harvesting operations is not new to date growers, but recent legislative action on both Federal and State levels with respect to harvest labor is forcing the industry to accelerate its efforts to find a method whereby dates can be harvested mechanically. It is widely held by those close to the labor situation that after January 1, 1964 the bracero program will be terminated or become so restrictive as to in effect be terminated. If this is true, it is imperative that mechanical harvesting be developed for there will be little or no labor available to do the job otherwise.

It was with these thoughts that the Committee about three years ago became interested in the prospects of a program for harvesting dates mechanically. It did so then only because the industry was in want of direction, because public agencies conducting research are more receptive to programs sponsored by an entire industry, and because initial results can be obtained more efficiently when efforts are channeled through a single agency. Once the program gathers momentum, the Committee's role will be a diminishing one.

The first step in the program was to obtain the interest and the cooperation of the agricultural engineering groups of the United States Department of Agriculture stationed at Davis and of the University of California, Davis, for it was these groups who pioneered mechanical fruit harvesting and who in turn were best qualified to mechanize date harvesting. With their splendid cooperation and understanding of the matter, we were able to outline an entire program which will lead, we believe, to a solution of the problem.

The first phase of the program called for a quality evaluation

study of dates harvested from bunches picked clean in only one pick compared with dates harvested in two or three picks as is the current practice. This was done because experience with mechanical harvesting devices revealed that they are not sufficiently selective. That is, when they are used, mature as well as immature fruit is harvested. Thus, if dates were to be harvested mechanically, it would be necessary to hold them on bunches until nearly all of them were mature, to minimize the loss of immature fruit. This, however, would cause some of the dates to be harvested later and become drier than normal.

These evaluation studies were conducted during the past two years by Mr. Roy Nixon of the U. S. Date Field Station and reported elsewhere in this bulletin. To the surprise of most people, Mr. Nixon found that there was very little difference from a quality standpoint in the dates harvested in one pick as against those harvested by the normal method. Any quality difference found would be overshadowed by cost savings alone, even if there were no other compelling reasons to harvest in this manner. Thus a major hurdle was cleared for mechanically harvesting.

Consideration next was given to the means whereby dates could be mechanically removed from the bunches. This was a problem for the engineers. After considerable investigation of various strippers and shakers, it was concluded by them that the dates can best be removed from bunches with a minimum of damage when the bunches are shaken with a vertical motion. They then proceeded to develop such a shaker.

While it was deemed preferable to shake the bunches while attached to the palm, it was found that the forces required for shaking in this

manner were too great to permit this. Therefore, the shaker was designed to operate near ground level and to shake bunches after they had been cut from the palms. The shaker can remove dates from bunches in as little as 3.5 seconds.

This brings us up to the plans for the coming year for testing the feasibility of mechanically harvesting dates under field conditions. Two methods of harvesting will be tested. In one case, the shaking will take place in the field, and in the other case, shaking will be tried at the packing house. Results from the two methods will then be compared in order that a complete, economical system can be developed.

For the field experiment, a two-tree tower previously constructed will be modified for the trials. Broadly, it is planned for these trials that the bunches will be cut from palms, lowered in a tray, and then placed in the shaker. When shaken from the bunch, the dates will fall into a bulk bin which when full will be fork-lifted to a truck for transportation to the packinghouse. Once at the packinghouse, the dates will be handled in a conventional manner.

In the packinghouse trial, date bunches will be cut and lowered from the trees into bins or trailers in which they will be transported to the packinghouse. Once there they will be fed to the shaker and the dates then will be processed much as they are at the present time.

Present plans tentatively call for 2,000,000 to 3,000,000 pounds to be harvested mechanically during this coming year. This amount would seem to be sufficient to enable a full evaluation of the problem and thereby enable the industry to fully mechanize for the following crop year, if the need arises as it appears that it will at the present time.

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